Inductor Heater (Half Bridge) Demo Board

User Manual

Revision History

Date	Author	Change of Records
2010-03-12	Kevin. Lin	V1.1.0, First draft
2010-08-5	Kevin. Lin	V1.1.0, add figures
2010-10-11	Kevin. Lin	V1.1.1, modify the Figure 6.2
2010-11-17	Kevin. Lin	V1.2.0, update the power level, Figure 6.2. add error code

This manual contains 26 pages.

Contents

1 Preface

1.1 About This Book

This book provides a detailed hardware description of the half bridge inductor heater board. The demo board is a reference platform for half bridge inductor heater design.

This *Inductor Heater (Half Bridge) Demo Board User Manual* is written for software, hardware, and system engineers, who are developing their own inductor heater project.

Table1.1 shows the summary of chapters included in this manual.

Chapter Title	Description
Preface	This chapter introduces the content of this book
Introduction of the Demo Board	This chapter introduces the information of the demo
System Level Architecture of the Board	This chapter explains the HW design of the demo board
How to Operate the Demo Board	This chapter describes how to operate the demo board by front board
Debugging and Programming	This chapter introduces how to connect the demo board to the adapter.
Schematic and BOM	This chapter shows the schematic and BOM of the demo

Table 1. 1 Chapter Summary

1.2 Reference Material

Use this book in conjunction with:

- Inductor Heater (Half Bridge) FW User Manual v1.1.0

2 Introduction of the Demo Board

2.1 Introduction

The Inductor Heater (Half Bridge) Demo Board is a reference design for customer. It contains two part, namely main board and front board. They are controlled by only one MCU.

The main board is built around Fujitsu MB95F430 serial MCU. The abundant modules and peripherals make it very suitable for Inductor Heater design no matter a half bridge style or a quasi resonant one.

The front board adopts LED display and capacitive touch buttons. It supports max 8 single LEDs, a LED module and 8 buttons.

2.2 Feature

This demo board supports these features below.

- Support 8 single LEDs and a LED module (8segments) max.
- Support 8 touch sense buttons
- Afford debugging interface for MCU and tuning interface for touch sense chip
- 9 power levels:600w,700w,900w,1200w,1400w,1800w,2000w,2400w,3000w.
- Three modes: constant power, constant temperature, timing.

2.3 Demo Board Module

Figure 2.1 shows the front view of the main board and the modules.

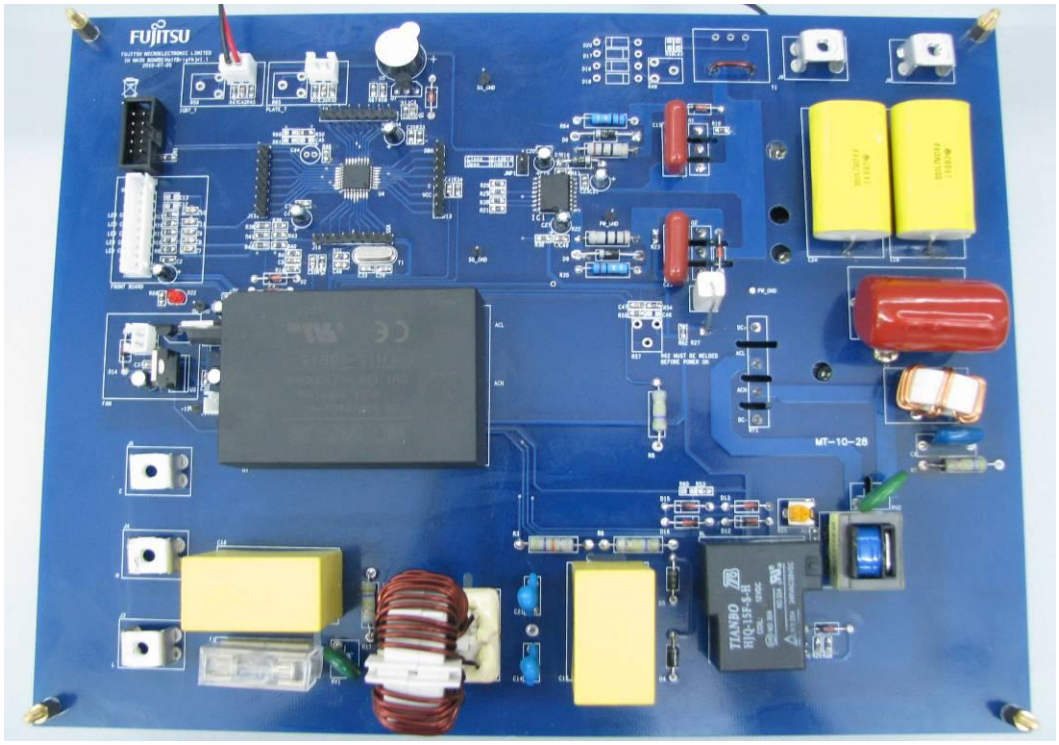

Figure 2.1 main board

Figure 2.2 shows the front view of the front board and the modules .

Figure 2.2 Front Board

3 System Level Architecture of the Board

3.1 Board Block Diagram

Figure 3.1 gives a system level architecture of the demo board. It has these sections: control, power supply, resonant circuit.

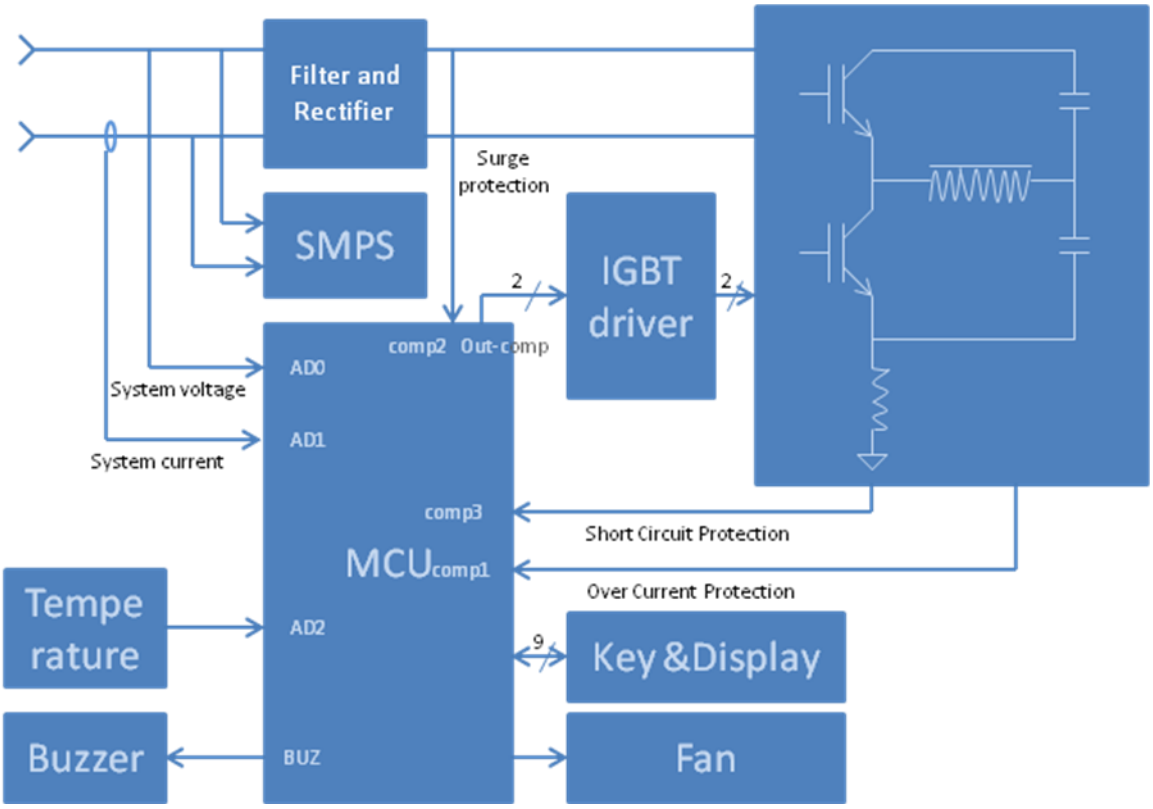

Figure 3. 1 Board Block Diagram

3.2 Control Module

The Control Module is based on the MB95F430H. It has several specialized hardware peripherals, like 16-bit output compare unit, 10-bit ADCs, internal voltage comparator, OPAMP and buzzer driver, which are required for inductor heater control.

3.2.1 **MCU Socket**

The demo board uses a LQFP32 footprint for MB95F430. Additionally ,there is test pins for each pin of MCU.

3.2.2 **Key and Display**

There are 8 single LEDs (D1-D8) and a LED module on the front board. The LEDs indicate the mode that the inductor heater is being in. The LED module displays the output power Level in constant power mode, temperature in constant temperature mode or time in timing mode.

All the keys are capacitive touch sense buttons. This function is implemented through AT5088 which is an ASIP for capacitive touch application. The AT5088 can support 8 buttons max.

Figure 3.2 shows the key and display definition

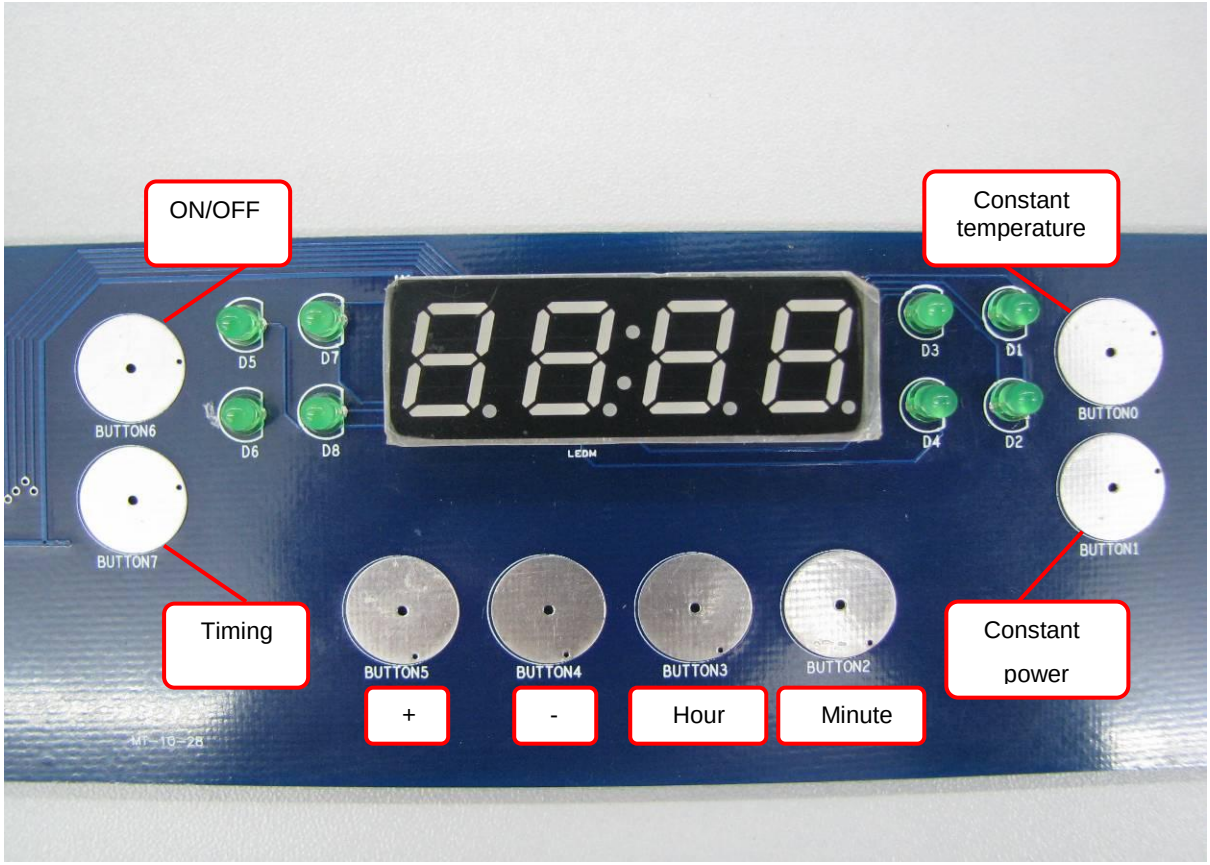

Figure 3. 2 Key Definition

The front board is connected with the main board through the 10-pin port including 5 wires for LED COMs, 2 wires for I2C bus and 2 wires for GND and +5V. The socket J2 on the front board is prepared for AT5088 tuning.

Figure 3.3 shows the connector.

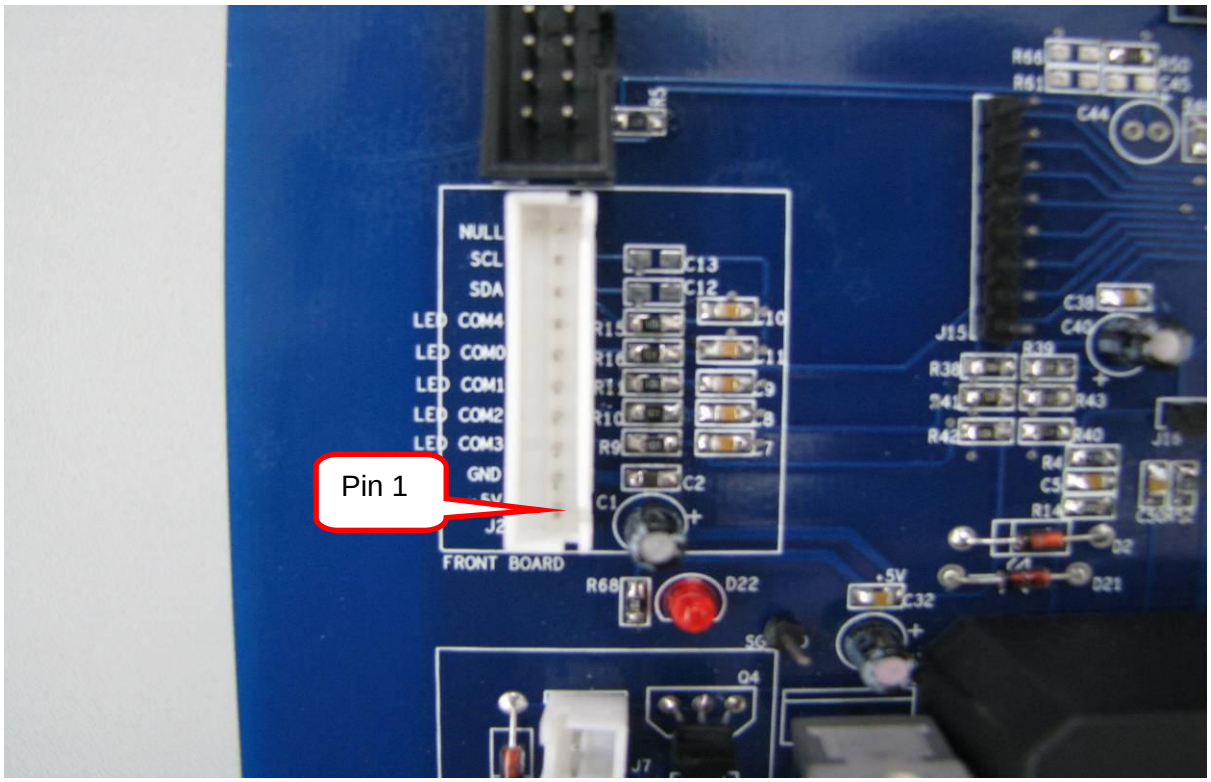

Figure 3.3 Connector to Front Board

The table below shows the pin definition of front board connector.

Table 3.1 Connector Definition

Pin Number	1	2	3~7	8	9	10
Name	+5v	GND	COM0~COM4(LED)	SDA	SCL	NC

3.2.3 **Fan and Buzzer**

When the inductor heater works, the fan need to work at the same time to chill the heat-sink, and decrease the temperature of the rectifier module and IGBTs in advance. The fan is a 12v driving set. A 7812 is used to convert the 15v to 12v.

The buzzer module is located on the main board, and it is drove by the specialized BUZ pin of the MCU.

3.2.4 **Temperature Measure Circuit**

In order to avoid the IGBT failure caused by over temperature, a NTC is placed on the top of IGBT Q1 to monitor the temperature.

Apart from the NTC on IGBT, there is another NTC is used to measure the temperature of the pot. It is placed in the middle of the wire plate where is close to the bottom of the pot.

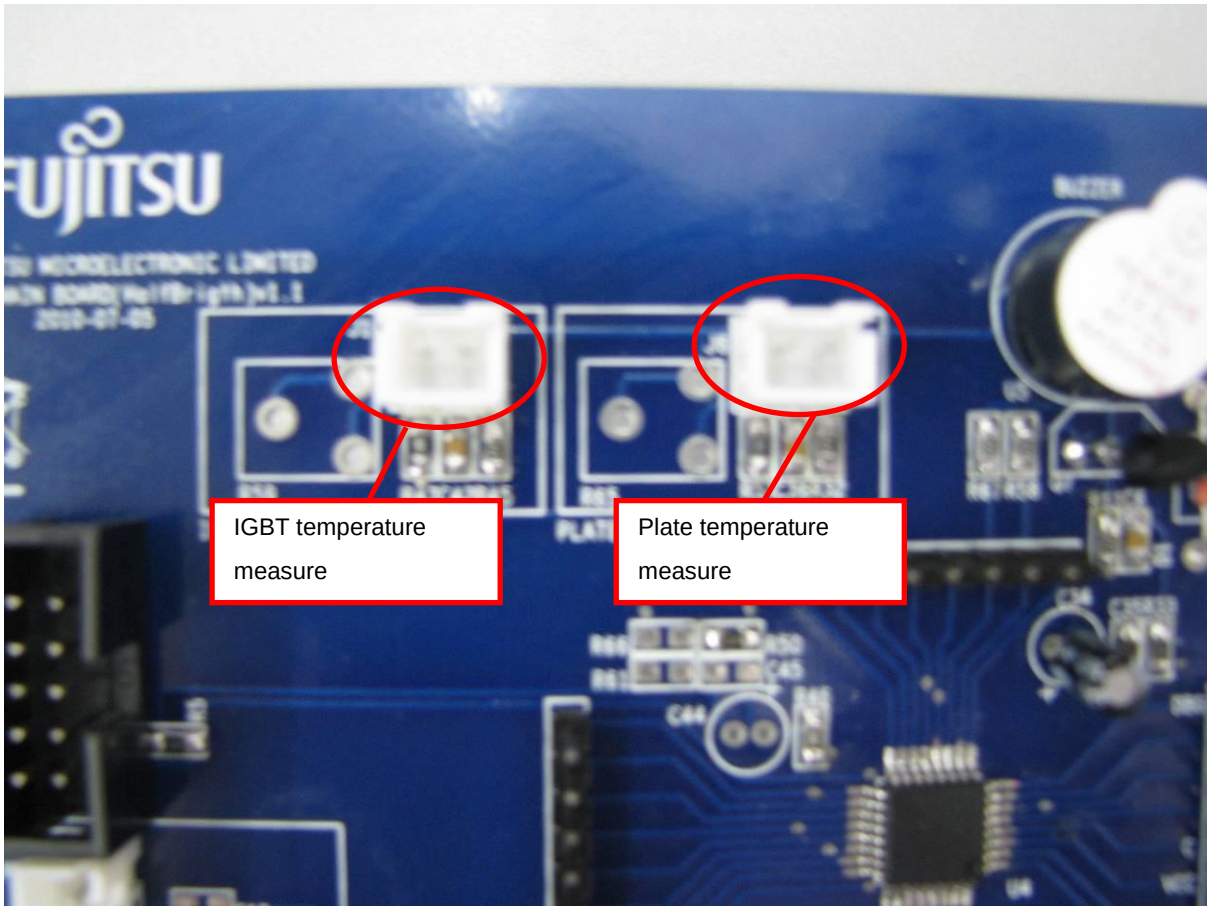

Figure 3. 3 Temperature Measuring Port

3.2.5 **Debugger Interface**

Socket J1 on the main board provides an interface for BGMA with MCU. The user can program the MCU or do debugging using the BGMA.

3.3 Power Supply

3.3.1 **SMPS**

A +15v DC block power supply (U1) serves as the main power supply to the control section of the demo board. The +15v power supply is supplied to the gate driver directly. A +12v power supply for the fan is generated using a regulator (U3). The +5v is also generated from +15V using the regulator U2.

3.3.2 **Filter and Rectifier**

Before entering into the resonant sink, the 50HZ AC power has to be change to DC-Link by the Filter and Rectifier stage. The filter part consists of some protection components, induction and capacitors, such as fuse (F1), relay (RL1), inductor (L2), and capacitor (C16, C14, and C21).

Rectifier module RL1 convert AC to DC, then the DC power go through the L1 and C22 to the resonant sink.

A current transformer T2 is embedded in the circuit for AC current measure.

For more information please refer to the chapter “Schematic and BOM”.

3.4 Resonant Circuit

3.4.1 **IGBT driver**

The IGBT driver circuit is built around IR2113 manufactured by IR. There are two power supplies for it. One is +15v which will supply power to the IGBT gate, and another is +5v which supply power to the logical part of the component.

JMP1 is used to disable or enable the driver output. When the jumper is open , the driver output will be enabled ,or it will be disabled.

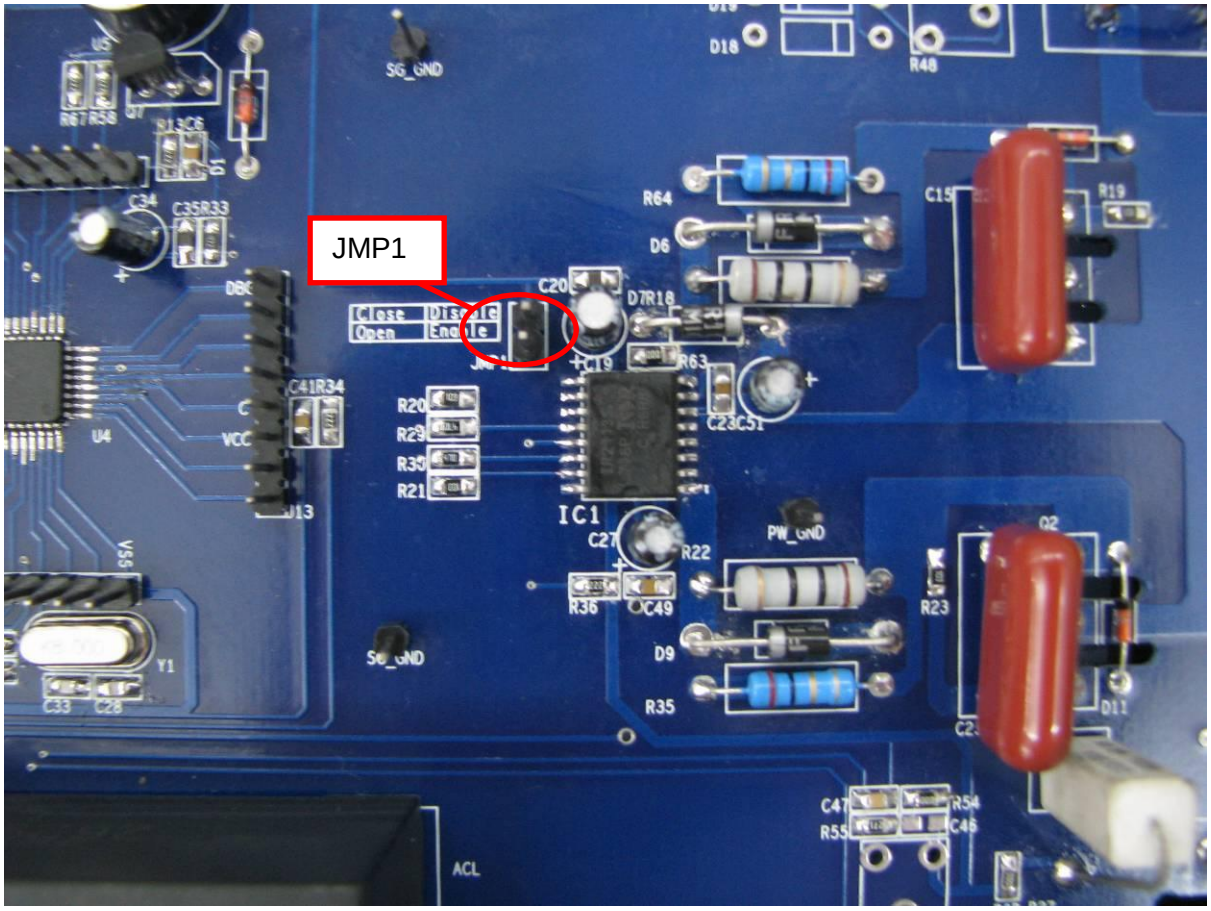

Figure 3. 4 IGBT Driver Block

3.4.2 **Resonant Tank**

IGBT Q1 and Q2, C18, C24 and wire plate make up the main part of the resonant tank. J8 and J9 sever as the headers for wire plate connection. Current transformer T1 is added to the resonant sink serial with the wire plate. It will transform the current to the MCU for over current protection. A heat-sink is used here to disperse the heat generated by IGBTs and rectifier.

4 How to Operate the Demo Board

4.1 Assemble the Platform

This Demo Board Set consists of such parts:

- Main board
- Front board
- Wire plate
- Fan
- One 10-wire bus

Figure 4.1 shows the assembled demo board platform.

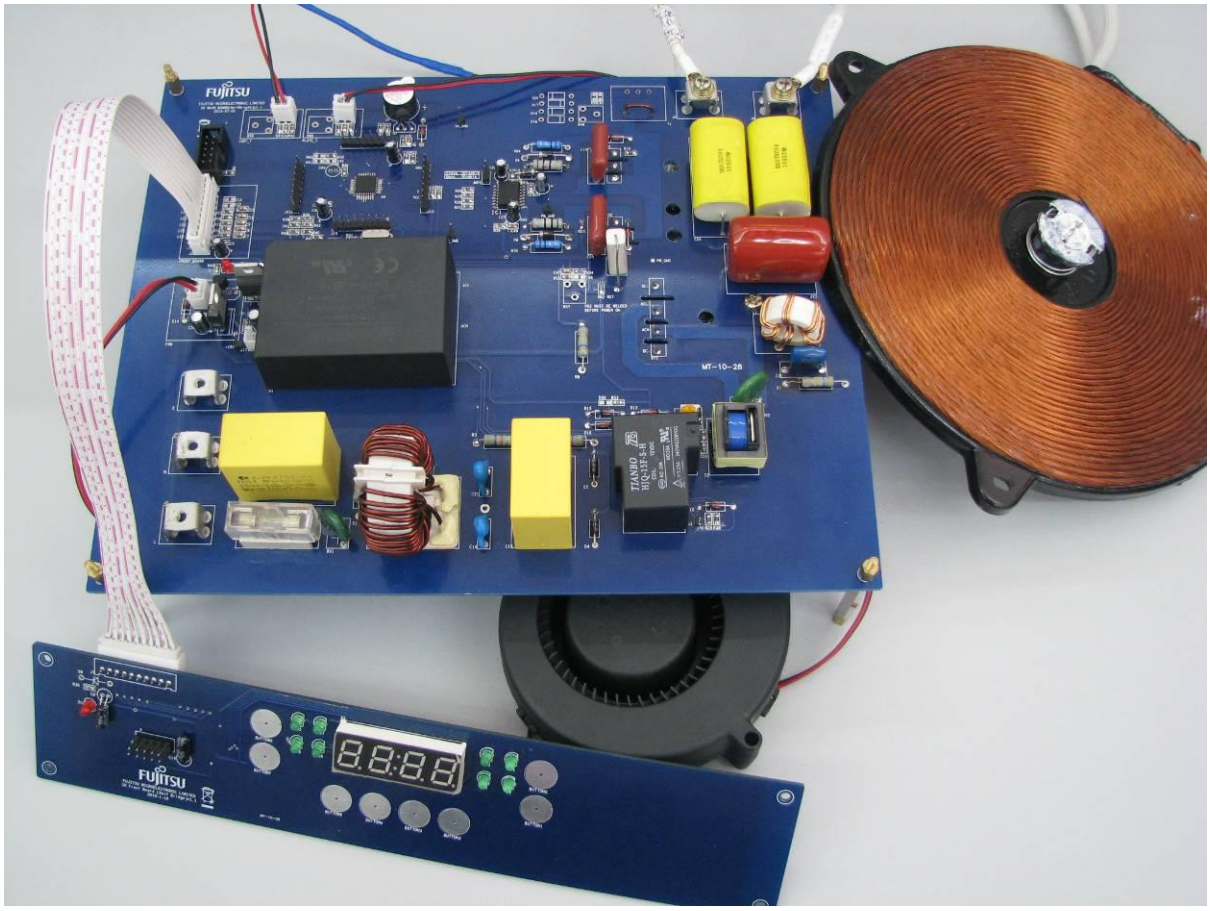

Figure 4. 1 Demo Platform

4.2 Operate the Demo Board

4.2.1 **Power ON/OFF**

If the main board is connected to 220v,The MCU will run immediately, but the power stage doesn't work. User can drive the relay to be on by touching ***BUTTON6***, then the system run in standby mode . The led D5,D7 on the front board will light as indication of standby mode. The D1~D8 and LED module will not light on. User can also shift the relay to be off by touching the ***BUTTON6*.**

All mentioned below can be done only after the system is in standby mode.

Figure 4. 2 Standby Mode

4.2.2 Constant Power Mode

When touch the ***BUTTON1*** after the system is in standby mode, the system enters constant power mode. D4 and D2 will be on and the led module will display the power level that indicates the output power.

User can touch the ***BUTTON5*** or ***BUTTON4*** to select the power level. The first touch to each of the two buttons will trigger the selecting process with figure flickering. Touching ***BUTTON5*** increases the power level, while touching ***BUTTON4*** decreases the power level. The selection will be confirmed until 5 seconds after each touch.

Figure 4.2 shows the constant power mode.

Figure 4. 3 Constant Power Mode

4.2.3 **Constant Temperature Mode**

Touch the ***BUTTON0*** will shift the system to constant temperature mode from constant power mode or standby mode. D3, D1 will light on. The figure shown by led module means the target temperature that user set.

The user can touch the ***BUTTON5*** or ***BUTTON4*** to change the target temperature.

Figure 4.3 shows the constant temperature mode.

Figure 4. 4 Constant Temperature Mode

4.2.4 Timing Mode

If the system is already in constant power mode or constant temperature mode, the user can touch the ***BUTTON7*** to make system entering timing mode. The system will run in constant power mode or constant temperature mode until the time is out. After that, it will back to standby mode automatically.

In timing mode, user can touch the ***BUTTON3*** or ***BUTTON2*** to select hour or minute setting, and touch the ***BUTTON5*** or ***BUTTON4*** to change the content. The figure which is in setting will flicker in frequency of 1HZ as the same as mentioned before. The rang of time is 1minute to 1hour and 59 minutes.

Figure4.4 shows the timing mode.

Figure 4. 5 Timing Mode with Constant Power Output

Note:

1. User can quite constant power mode, constant temperature mode or timing mode by ***BUTTON0, BUTTON1, BUTTON7*** respectively.

2. If the system is in timing mode, the touch to ***BUTTON0*** or ***BUTTON1*** is invalid.

3. In constant power mode or constant temperature mode, the touch to ***BUTTON3*** or ***BUTTON2*** has no effect.

5 Debugging and Programming

5.1 Debugging Tool Connection

Figure 5.1 shows how to connect the adapter to demo board.

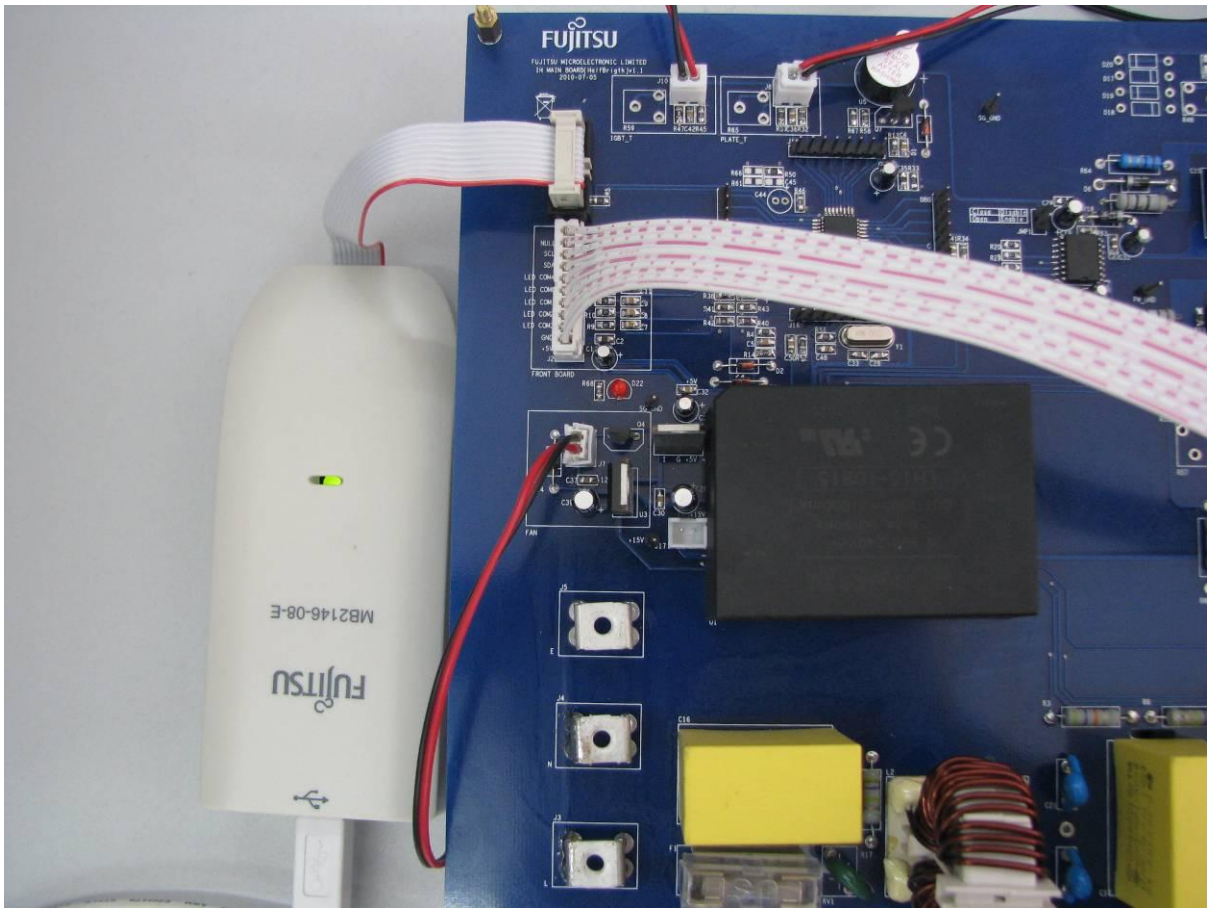

Figure 5. 1 Adapter Connection

5.2 Overview of Project

The project can be opened using SOFTUNE V3.0. The files are listed in the left table. Figure 5.2 shows the project.

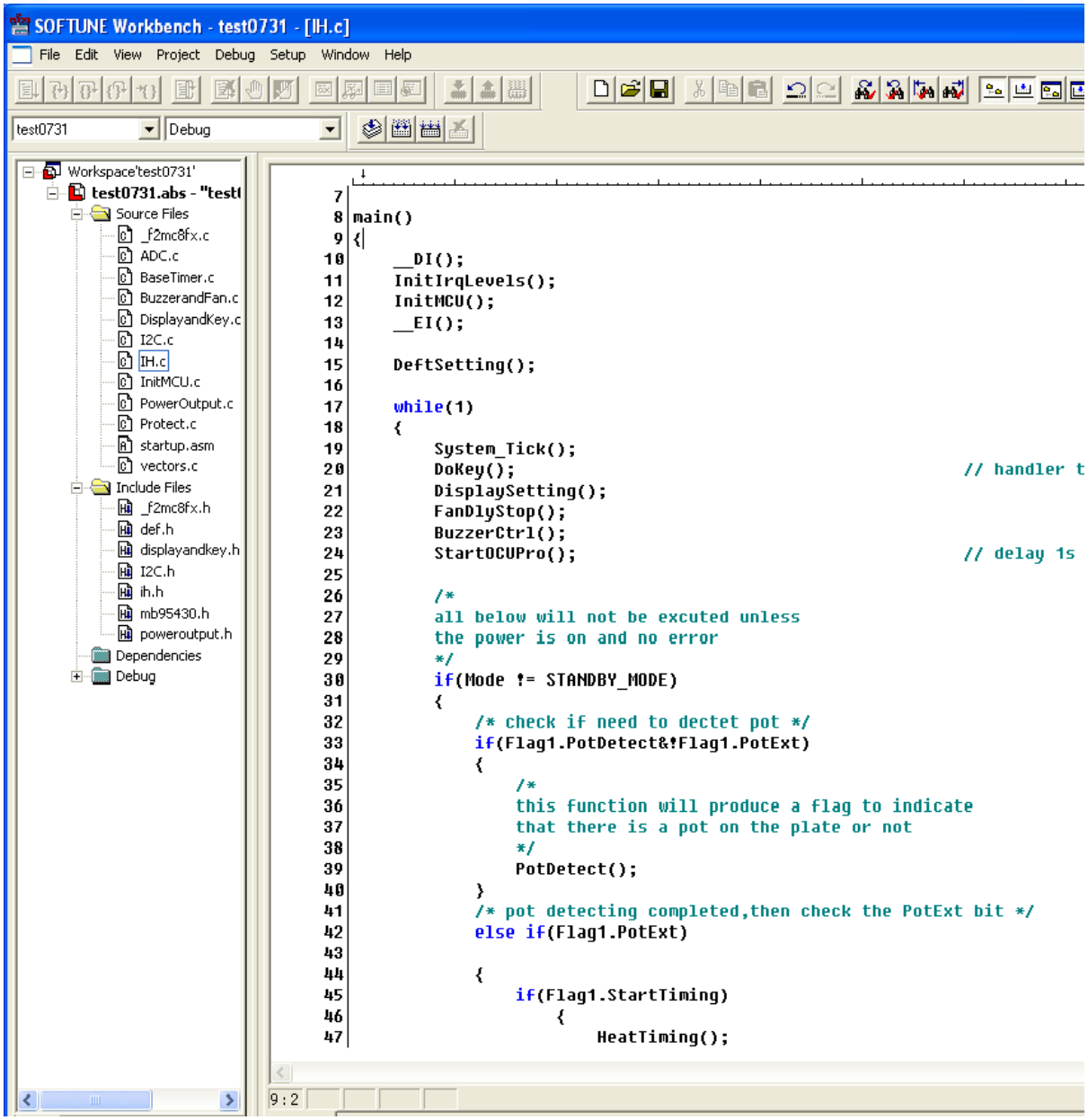

Figure 5. 2 Project

More information for the SOFTUNE V3, please refer to the SOFTUNE Workbench USER’S MANUAL.

6 Schematic

Figure 6.1 shows the front board circuit.

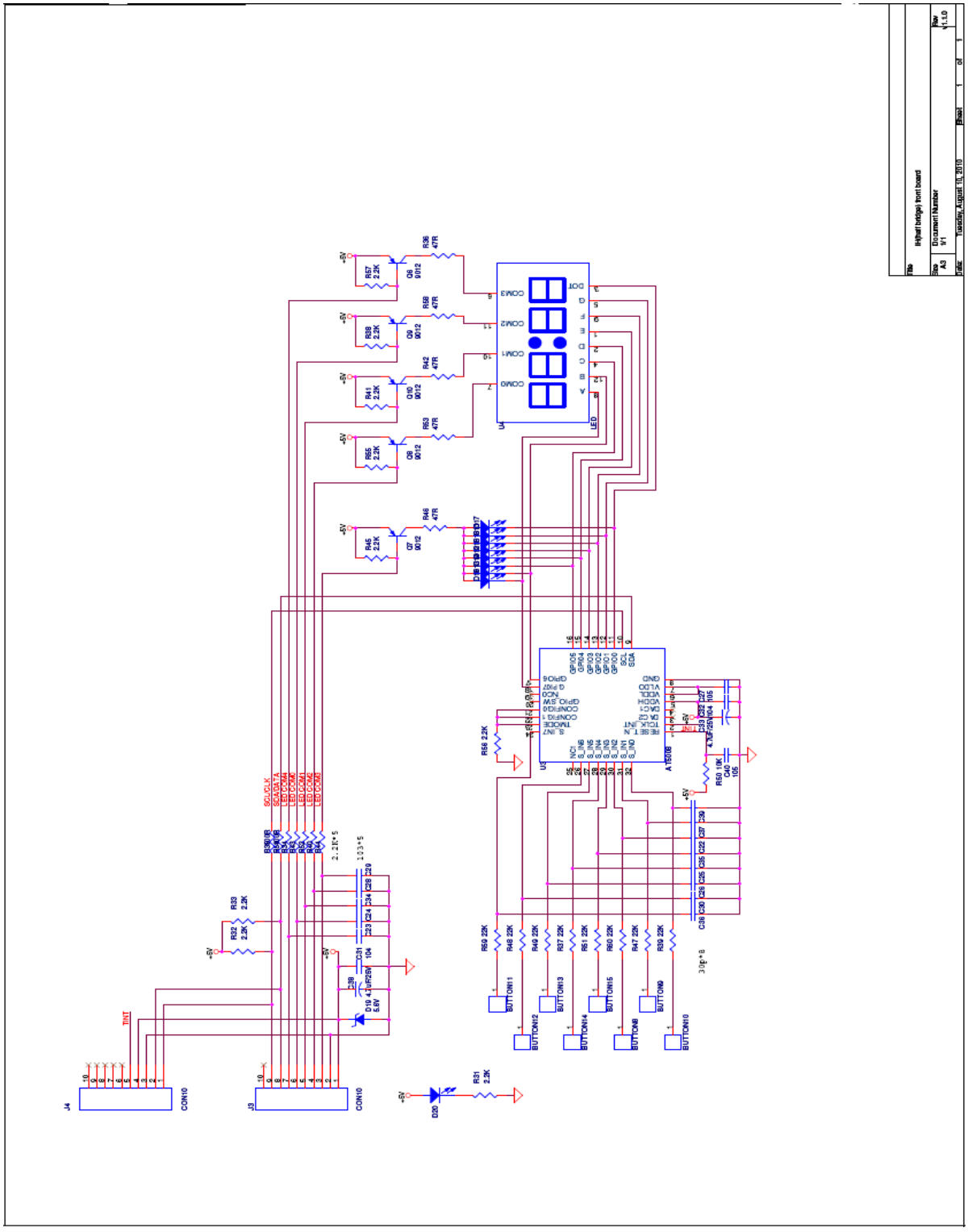

Figure 6. 1 Front Board

Figure 6.2 shows the main board circuit.

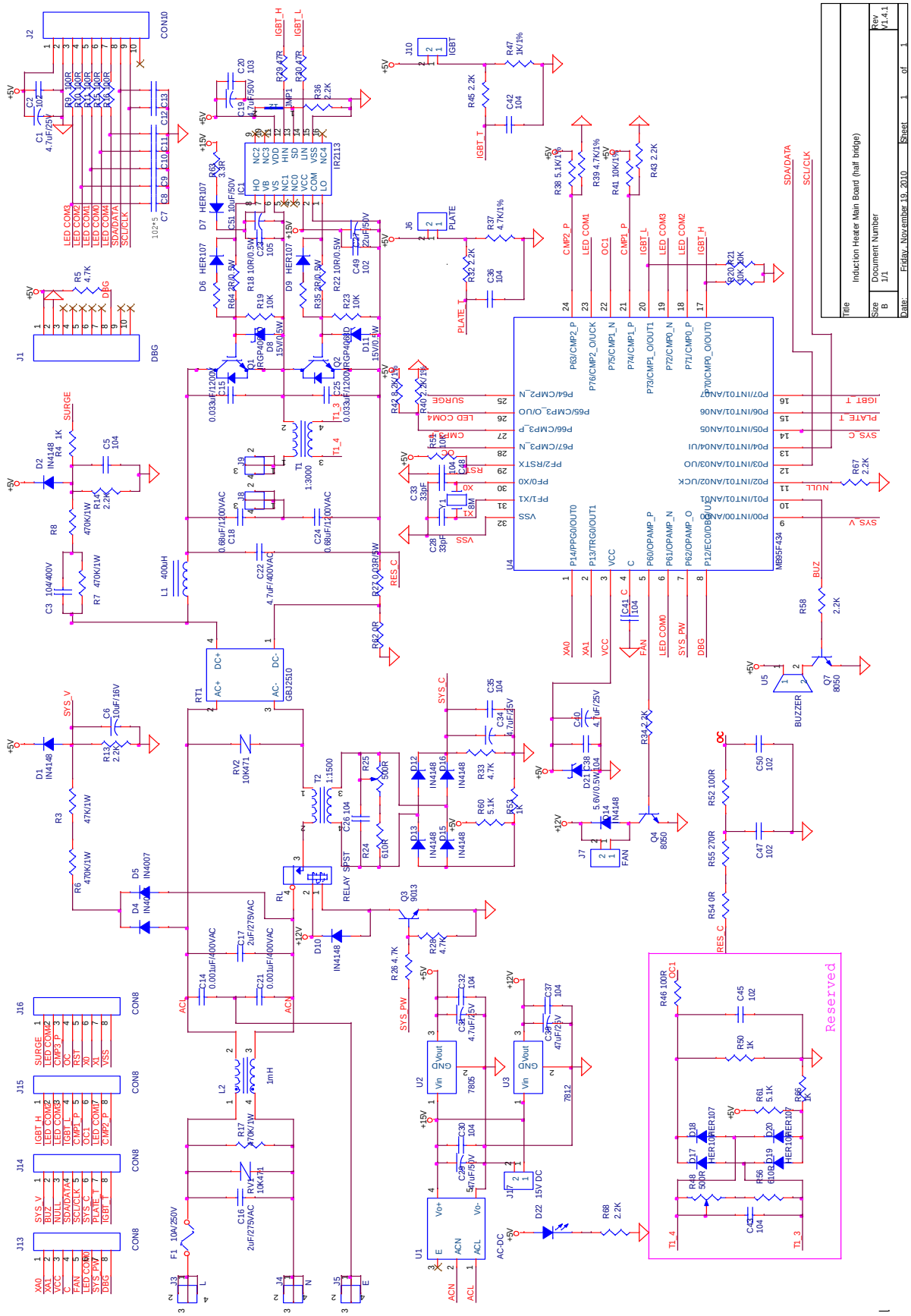

Figure 6. 2 Main Board

7 Additional Information

For more information on FUJITSU MICROELECTRONICS products, please visit the following website at:
Simplified Chinese Version: http://www.fujitsu.com/cn/fmc/services/mcu/mb95430/
English Version: http://www.fujitsu.com/cn/fmc/en/services/mcu/mb95430/

8 Appendix

8.1 List of Figures

8.2 List of Tables

8.3 MCU Pin Assignment

Pin Number	Pin Name	Function
1	PG2/PPG0/X1A/OUT1	Sub clock
2	PG1/TRG0/ADTG/X0A	Sub clock
3	Vcc	Vcc
4	C	C
5	P60/OPAM_P	Fan
6	P61/OPAM_N	LED COM0
7	P62/OPAM_O	SYS_PW
8	P12/EC0/UI/DBG	DBG
9	P00/INT00/AN00	System voltage measuring
10	P01/INT01/AN01/BZ	Buzzer
11	P02/INT02/AN02/UCK	NULL
12	P03/INT03/AN03/UO	SDA for I2C
13	P04/INT04/AN04/UI	SCL for I2C
14	P05/INT05/AN05/TO0	System current measuring
15	P06/INT06/AN06/TO1	Plate temperature measuring
16	P07/INT07/AN07/EC0	IGBT temperature measuring
17	P70/CMP0_O/OUT0	IGBT driver H
18	P71/CMP0_P	LED COM2
19	P72/CMP0_N	LED COM3
20	P73/CMP1_O/OUT1	IGBT driver L
21	P74/CMP1_P	OC protection reference voltage
22	P75/CMP1_N	OC input
23	P76/CMP2_O/UCK	LED COM1
24	P63/CMP2_P	Surge protection reference voltage
25	P64/CMP2_N	Surge input
26	P65/CMP3_O/UO	LED COM4
27	P66/CMP3_P	Short circuit protection reference voltage
28	P67/CMP3_N	Short circuit protection
29	PF2/RSTX	Reset
30	PF0/X0	oscillator
31	PF1/X1	oscillator
32	Vss	Vss

8.4 ErrorCode

Error Code	Description	Notes
E0	HW_STOP is set	
E1	Low voltage	the power supply is lower than 185V
E2	Over voltage	the power supply is higher than 256V
E3	Pot temperature sensor is short	
E4	Pot temperature sensor is open	
E5	IGBT temperature sensor is short	
E6	IGBT temperature sensor is open	
E7	Pan over temperature	the temperature of pan bottom is higher than 200 ºC
E8	IGBT over temperature	the temperature of IGBT is higher than 80 ºC